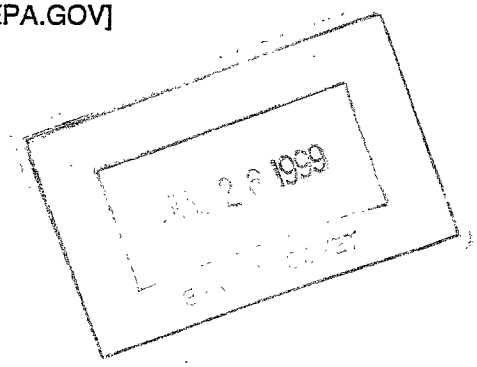
A-95-35
II-A-6

Brahim Richani

From: Chris Lindhjem[SMTP:LINDHJEM.CHRIS@EPAMAIL.EPA.GOV]
Sent: Thursday, October 23, 1997 8:30 AM
To: Brahim Richani
Subject: Gen Sets and Others



GEN_SET.MDB

Sorry I took so long, and not being clearer on the phone. I'm leaving EPA
in two weeks and I am a bit distracted.

This file is quite small, only 971 rows. Might be easier to deal with it in a
spreadsheet afterall.

Brahim c:\mydocument\gen-set.mdb

Power Data Research

Brahim Richani

From: Chris Lindhjem[SMTP:LINDHJEM.CHRIS@EPAMAIL.EPA.GOV]
Sent: Thursday, October 23, 1997 2:09 PM
To: Brahim Richani
Subject: Gen Sets and others

In addition to the information from PSR, we are currently modelling with nothing but someone's guess, the fraction of the PSR equipment that is mobile. the section from our documentation describing these fractions is
shown below.

any questions??

Mobile and Stationary Nonroad Engines

In addition, it was necessary to determine the fraction of engines
used as mobile and stationary emission sources. The legal definition of a
stationary engine is an engine that resides in one place more than 12 months continuously. Engines that might appear stationary are in fact considered as mobile. For example, a palette mounted engine is easily moved from one site to the next with a forklift or other type of truck over
the course of several months. To account for mobile nonroad engines, EPA used the information derived from a report to the California Air Resources Board by Booz, Allen, and Hamilton and given in Table 3 to provide fractions of engines used as stationary and mobile engines. These fractions were applied to the state equipment populations provided by PSR.

Table 2 Fraction of Mobile and Stationary Generator Sets, Pumps, Compressors, and Welders

Power Range (Hp)	Percent Mobile Equipment
0 to 25	90
25 to 40	90
40 to 100	70
100 to 175	20
175 to 300	15
300 to 500	10
500+	0

G - Gasoline
N - Natural Gas
H - ?
L - LPG
X - Multifuel

PSR
Scott Tierney
612-454-0144

Talked to Scott Tierney, Oct. 28.
- No readily Available field to identify stationary vs non-road units
He can discuss w/ industry experts to estimate the proportions of such population.
We will look at a list of fields available for their data, and some contacts by Friday the 31st

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Power Systems Research

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FACSIMILE - PLEASE DELIVER

11/17/97 2:45 PM ST. PAUL OFFICE

TO: Brahim Richani

FROM: Scott Gierdal **Pages: 13**

Telephone: (612) 454-0144 Facsimile: (612) 454-0760 www.powersys.com
1301 Corporate Center Drive, Suite 113, Eagan, MN 55121 USA

Brahim-

Sorry for the delay- please find attached information regarding the PartsLink database. Do not hesitate to call if you have any questions.

Regards,

S. Gierdal

INTRODUCTION

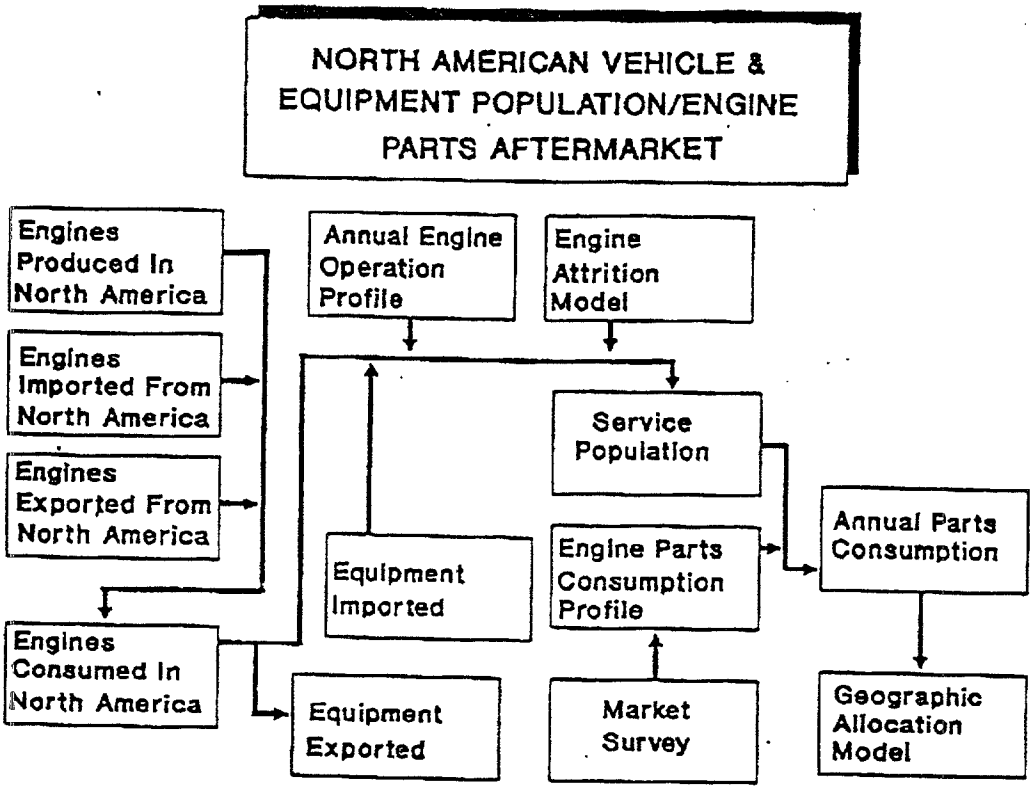
The *North American Engine PartsLink Database* is the result of more than ten years of continuous research and development to produce a realistic method of analyzing engine product life cycles and the realistic simulation of parts consumption by engines in North American operation. In the final analysis, this database is a computerized model which we believe closely resembles actual field experience.

In this booklet we will describe the underlying assumptions and methodology which are utilized to formulate our *PartsLink* database. This will be helpful to the analyst in interpreting the data and in applying it to business evaluations. This database is structured in a way which allows the analyst to adjust many of the underlying assumptions, to experiment with the consequences of variations in assumed values and configurations. Procedures to accomplish these adjustments are also outlined here.

Among the unique features found in this database are a realistic distinction in the lifetime experience of an engine dependent upon its application and its original design. Moreover, the replacement rates and parts consumption profile, which is structured for every engine in each discrete application, is based upon extensive, real-life experience. Continuing research over an extended period of time will bring many enhancements to this database. Our experience in the development of numerous, widely used engine industry databases tells us that the greatest increase in utility, reliability and value will come from its regular use within the industry.

An extensive group of well established suppliers of original and aftermarket components utilize this database on a regular basis. The combined knowledge and experience of these users is a further contribution to the on-going research and development effort which supports this database. Several important elements are critical to the derivation of the various reports produced by this database. They include:

- Population Calculation
- Parts Consumption Profile
- Geographic Distribution



We will discuss the methodology employed in deriving each of these, as it is important for the analyst to have a good intuitive understanding of the way in which this data is derived and formulated.

POPULATION CALCULATION

In order to arrive at a reliable population for a specific engine in a discrete application, several important steps are necessary. They include:

- Establishment of an historical sales record
- Definition of an accurate exports profile
- Determination of mean engine life
- Composition of an acceptable attrition methodology

Sales Record

The historical sales record has been compiled through the use of several resources, including *ENGINDATA*, Power Systems Research proprietary engine market database which provides a continuous 18-year record of engine sales and production in North America. This sales record includes:

- Identification of engine production and installation in original equipment by:
  - Engine Model
  - Each of 99 discrete engine applications which are common to the engine applications used in this North American database

This 18-year record of engine installations recreates a comprehensive record of all engines installed in original equipment in North America, whether they are domestically produced or imported. The sales record is developed by Power Systems Research through on-going analysis of original equipment installations. The methodology utilized to develop *ENGINDATA* includes continuing contact with over 1,600 of the largest engine-driven original equipment manufacturers in North America to determine their annual engine installation rates by make, model and ultimate application. In addition, this data is compared with published statistics from trade associations, governmental agencies and engine and original equipment manufacturers. This widely respected database is utilized in its own right as an important analysis tool for evaluating engine installation trends in North American original equipment.

In addition to North American produced original equipment, a sales record has been established for imported engine-driven original equipment. This data is derived through our continuing research of import data published by the Department of Commerce and analysis of retail sales of engine-driven products through trade association, government and original equipment importer data. Not surprisingly, we believe the import data is most accurate in the well documented automotive areas and least accurate in the less defined off-highway equipment areas. Nonetheless, it should be pointed out that a considerable degree of effort

has been undertaken to ascertain that imports of original equipment contained in this database sales record are reconciled with published data available from trade and government sources. The combination of sales records for imported, engine-driven original equipment and domestically produced original equipment provides a baseline for further analysis of the units in operation in North America.

Export Records

A significant portion of the original equipment produced in North America is exported either initially or subsequent to its first use. Export records from the Department of Commerce are tabulated for each of the 80 discrete engine applications which are utilized in this database. For each of the years during which the sales record has been compiled, the units produced domestically and imported are reduced by the number of units exported. A key assumption in our export data lies in the fact that we assume that exports are spread proportionally among all original equipment manufacturers. This, of course, is not true in actuality, but it is the closest approximation we can make for most applications. For example, if 14% of all tractor loader backhoes are shown to be exported in 1989, the assumption which is included in our calculation is that 14% of John Deere tractor loader backhoes are exported as are 14% of J.I. Case tractor loader backhoes and 14% of all other OEM tractor loader backhoes. Original domestic engine production also has been relieved by engines which are originally exported for use in equipment produced outside North America.

% OF DOMESTIC PRODUCTION EXPORTED

Application No.	Name	% Diesel	% Gas
1	Truck Class 5	0	0
2	Truck Class 6	8	2
3	Truck Class 7	11	1
4	Truck Class 8	11	0
5	Truck Class 1 & 2	10	3
6	Truck Class 3 & 4	7	3
7	Cars	3	3
8	Buses	1	2
9	Generator Sets	8	14
10	Air Compressors	16	5
11	Pumps	6	3
12	Oil Field Equipment	32	27
13	Underground Mine Equip.	18	5
14	Refrigeration/AC	22	3
15	Tactical Military Equip	32	21

Application No.	Name	% Diesel	% Gas
16	Terminal Tractors	13	1
17	Welders	11	6
18	Forklifts	9	11
19	Other Material Handling	11	6
20	Locomotive	16	5
21	Scrubbers/Sweepers	9	12
22	Exports-Med/Hvy Trucks	100	100
23	Surfacing Equipment	4	8
24	Forest Equipment	12	2
25	Marine Aux	16	28
26	Chippers/Grinders	14	4
27	Cranes	19	3
28	Excavators	13	4
29	Scrapers	17	0
30	Graders	16	2
31	Crawler Dozers	22	0
32	R/T Dozer	11	2
33	R/T Loader	23	6
34	Crush/Proc Equip	15	2
35	Paving Equip	16	5
36	Other Construction	9	8
37	Bore/Drill Rigs	22	1
38	S/S Loader	26	14
39	Rollers	13	5
40	Off-Hwy Truck	29	0
41	Pavers	16	2
42	Trenchers	8	6
43	Tractor/Loader/Backhoe	13	5
44	Irrg Sets	15	2
45	Ag Tractor	24	1
46	Other Ag Equipment	6	6
47	Combines	18	0
48	Swathers	5	3
49	Balers	8	0
50	Powerboats	12	16
51	Marine Com	5	3
52	Dist Loose	7	4
53	Trimmer/Edge/Cutter	6	16
54	Exports - Loose Eng	100	100
55	Ag Mowers	13	3
56	Snowblower	3	19
57	Cem/Mtr Mixers	6	5
58	Pressure Washers	5	5
59	Tillers	8	11
60	Dumpers/Tenders	6	3
61	Plate Compactors	6	6
62	Spec Veh/Carts	7	4
63	Lawn/Garden Tractors	13	3
64	Aerial Lifts	12	6
65	Lawn Mowers	22	3
66	Leaf Blower/Vac	11	5
67	Commercial Turf	23	3
68	Off-Hwy Tractors	17	9

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Application No.	Name	% Diesel	% Gas
69	Sprayers	8	5
70	Chainsaws	11	20
71	Snowmobile	2	9
72	Exports-Lt Truck Eng	100	100
73	Lt Plants	16	4
74	Other General Industrial	7	4
75	Wood Splitter	3	8
76	Other Lawn & Garden	8	5
77	Concrete/Ind Saws	8	8
78	Vehicle Repower	9	12
79	Sailboat Auxiliary	5	11
80	Railway Maintenance	9	2
81	Aircraft Support	31	3
82	Rear Engine Rider	11	2
83	Exports CKD	100	100
84	Rough Trn Forklifts	5	2
85	Hyd Power Unit	5	2
86	Exports - Marine Eng	100	100
87	Motor Home Chassis	3	3
88	Front Mowers	11	2
89	Gas Compressors	25	25
90	Exports-Car Engine	100	100
91	All-Terrain Vehicles	0	18
92	Off-Road Motorcycles	0	0
93	Mini-Bikes	0	3
94	Golf Carts	9	7
95	Tampers/Rammers	6	6
96	Shredders	11	5
97	Crawler Loaders	12	0
98	2-Wheel Tractors	13	3
99	Outboard Engines	12	19

Engine Life

For each of the more than 1,900 engines included in this aftermarket database and utilized both in North American produced original equipment and imported equipment. We have included a mean lifetime expectation. This mean lifetime expectation is not an official or documented expectation as provided by the manufacturer. It is, instead, the result of our continuing field research over more than 18 years of careful examination of engine applications in field use. These lifetime data are the subject of continuing research and evaluation and are reviewed annually as a result of our major operator survey.

The mean lifetime expectancy utilized in our database is simply the point in each engine model's life, expressed in hours, at which the engine, when operated at manufacturers' specified ratings under ideal conditions, would find 50% of engines originally placed in service still in operation. Many factors contribute to variations from this norm and these are accounted for in our subsequent calculations of lifetime attrition.

Attrition

In order to reasonably account for the way in which engines wear out in real life, we have presumed that engines are consumed as a function of the time over which they operate and the load which they carry over that time. Many manufacturers use an analog based on fuel consumption for an engine which similarly is based on time of operation and load. For example, a 100 horsepower engine which has a lifetime of 5,000 hours at that rating can be assumed to have a lifetime output of 500,000 horsepower hours. A straight-line relationship would say that if the engine is operated at 50 horsepower, its lifetime will be doubled, whereas if it is operated at 200 horsepower, its lifetime would be halved. This, of course, is not realistic and our attrition decay model will take this into consideration.

First, to establish a relationship between load and annual hours of operation, each of the 80 discrete applications for gasoline and diesel engines has been evaluated upon typical annual hours of operation and load factor normally experienced in that application. The load factor is simply the average operating level in a given application as a percent of the manufacturer's maximum intermittent horsepower rating. Each of these are shown on the enclosed table and they are important considerations in the way in which our attrition model is structured. These factors define the duty cycle which is experienced in each of these applications. From year to year, utilization rates in terms of annual hours will change, sometimes having a significant effect upon parts consumption and population changes.

Application No.	Name	Diesel Hrs/Year	Diesel Factor	Gas Hrs/Year	Gas Factor
1	Truck Class 5	305	37	296	30
2	Truck Class 6	306	46	300	39
3	Truck Class 7	973	50	335	51
4	Truck Class 8	1241	74	362	81
5	Truck Classes 1 & 2	364	23	283	18
6	Truck Classes 3 & 4	368	28	311	23
7	Cars	385	20	303	16
8	Buses	792	48	420	45
9	Generator Sets	338	74	115	68
10	Air Compressors	815	48	484	56
11	Pumps	403	74	221	69
12	Oil Field Equipment	1231	92	1104	90
13	Underground Mine Equip	1533	68	260	80
14	Refrigeration/AC	1341	28	605	46
15	Tactical Military Equip	260	62	225	68
16	Terminal Tractors	1257	82	827	78
17	Welders	643	45	208	51
18	Forklifts	1700	30	1800	30
19	Other Material Handling	421	59	386	53
20	Locomotive	848	63	15	91
21	Scrubbers/Sweepers	1220	68	516	71
22	Exports-Med/Hvy Trk Eng	0	0	0	0

Application No.	Name	Diesel Hrs/Year	Factor	Gas Hrs/Year	Factor
23	Surfacing Equipment	561	45	488	49
24	Forest Equip	1276	71	35	70
25	Marine Aux	2608	67	175	61
26	Chippers/Grinders	465	73	488	78
27	Cranes	806	43	415	47
28	Excavators	859	57	378	53
29	Scrapers	914	72	540	70
30	Graders	821	61	504	64
31	Crawler Dozers	936	64	700	80
32	R/T Dozer	899	59	900	75
33	R/T Loader	761	68	512	71
34	Crush/Proc Equipment	955	78	241	85
35	Paving Equipment	622	53	175	59
36	Other Construction	606	62	371	48
37	Bore/Drill Rigs	466	75	107	79
38	S/S Loader	818	55	310	58
39	Rollers	745	56	621	62
40	Off-Highway Truck	1641	57	450	80
41	Pavers	821	62	392	66
42	Trenchers	593	75	402	66
43	Tractor Loader Backhoe	1135	55	870	48
44	Irrigation Sets	749	65	716	60
45	Ag Tractor	475	70	550	62
46	Other Ag Equipment	381	51	124	55
47	Combines	150	70	125	74
48	Swathers	110	55	95	52
49	Balers	95	58	68	62
50	Powerboats	200	35	100	38
51	Marine Com	2244	41	943	45
52	Dist Loose	878	51	620	54
53	Trimmer/Edger/Cutter	60	43	34	68
54	Exports - Loose Eng	0	0	0	0
55	Ag Mowers	363	43	175	48
56	Snowblower	400	65	45	78
57	Cem/Mtr Mixers	275	56	84	59
58	Pres Washer	145	30	115	85
59	Tillers	172	78	43	71
60	Dumpers/Tenders	566	38	127	41
61	Plate Compactors	484	43	166	55
62	Spec Veh/Carts	435	65	65	58
63	Lawn/Garden Tractor	544	57	104	62
64	Aerial Lifts	384	46	361	46
65	Lawn Mowers	320	55	76	70
66	Leaf Blower/Vac	120	40	56	75
67	Comm Turf	1068	55	733	60
68	Off-Hwy Tractors	855	65	155	70
69	Sprayers	90	58	80	65
70	Chainsaws	70	60	26	92
71	Snowmobile	50	40	121	81
72	Exports-Lt Trk Eng	0	0	0	0
73	Lt Plants	535	78	318	72
74	Other General Industrial	878	51	713	54

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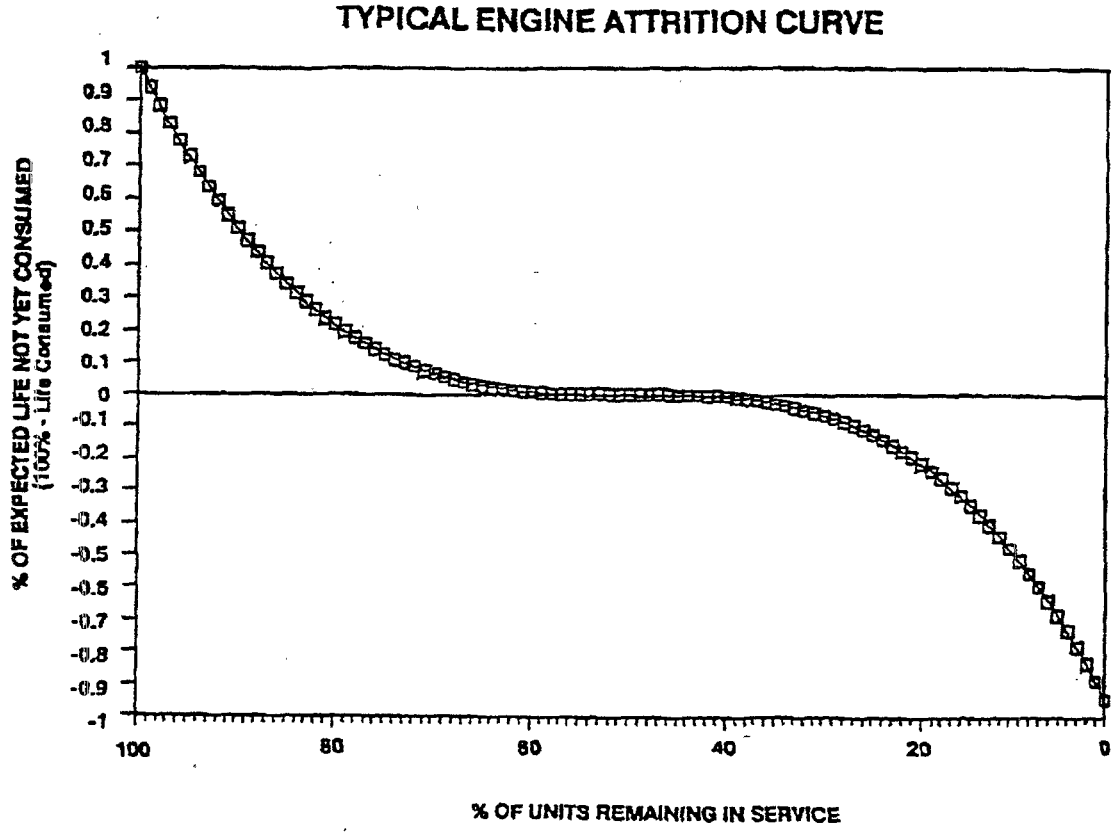
made for each of the applications in which it operates. This is compared to the number of years for which the engine has been in operation thus, the percentage of engines remaining in operation is calculated.



For example, assume that 500 of a specific engine model were placed into operation in forklift trucks six years ago, that the annual hours of operation are 600, the load factor is 50% and the engines have an expected lifetime of 2,000 hours. For a 70 horsepower engine, we will consume 21,000 horsepower hours per year. For a period of six years, we will have consumed 126,000 horsepower hours in each of these engines and this will translate into 90% of expected engine life. Matching this to our curve, we find that when 90% of engine life has been consumed (10% remains). Of the original 500 engines, 72%, or 360 engines will still be in service. This calculation is made for engines that were placed into service 5 years ago, 4 years ago, 3 years ago and so on, so that a summation of these total units in operation will provide a total population for this engine model in forklift trucks.

When these calculations have been made, we are able to arrive at a reasonable representation of the remaining service population. The population has been tested in specific cases - for example, specific engines fitted to registered vehicles. Generally, we have found the correlation to be in excess of 90%.

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GEOGRAPHIC DISTRIBUTION

One of the most important features of the *North American Engine PartsLink Database* is the ability to isolate specific segments of the market on a geographic basis. For many engines and application categories, the opportunity to review engine market volumes by specific territory is critical. For example, this feature allows manufacturers to evaluate the comparative market opportunity in different distributor markets or to evaluate the consequences of geographic changes in any single distributor market. It is, of course, also possible to analyze the market from a nationwide standpoint. The unit of geographic analysis within this database is any one of more than 3,200 counties.

The distribution of engine-driven products on a geographic basis is dependent upon the type of population and commercial activity experienced in any one of the counties included in the database. The commercial and demographic indicators necessary to make this distribution are supplied by the U.S. Department of Commerce Bureau of Census. The County Business Patterns database supplied by the Bureau of Census has been incorporated into the *PartsLink* database. Selected factors from the County Business Patterns are utilized to make assumptions about the number of units of any specific application utilized in each area. For example, in a specific county, the correlation between the number of construction employees and construction revenue, along with a number of other commercial activities, will determine the number of engine-driven wheel loaders expected to be found in that county.

One shortcoming of this assumption is the fact that it is unable to distinguish between manufacturer market shares, which can vary considerably on a regional basis. For the purposes of this database, an inescapable assumption is that which says that manufacturer market share nationwide will be distributed proportionately throughout the country. For example, it is assumed that Caterpillar's wheel loader market share in any given county is exactly the same as it is on a nationwide basis. This, of course, will not be true but it is the best representation available within the scope of this data file.

Correlation among major industry groups for each application is contained in the economics factors file. The correlation between each industry group for any specific application is weighted in the amount shown in this file.

Our experience has generally been very satisfactory in finding geographic representations based upon this widely used business database. The Department of Commerce updates the County Business Patterns regularly and, as a registered subscriber, we will continue to update this data file through the County Business Patterns as it becomes available.

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